Morphological Variability and Temporal Patterning in Marquesan Domestic Architecture: Anaho Valley in Regional Context

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INTRODUCTION

Residential structures are important repositories of information on domestic activities, social relations, and residential mobility (e.g., Graves and Green 1993; Green et al. 1967; Irwin 2004; Kahn 2005, 2006; Weisler and Kirch 1985). They also inform on historical relations, technological or engineering strategies, and environmental conditions (e.g., Oliver 1989 : 321–360). Chronological control, however, is crucial to fully understanding these dimensions of domestic architecture, as well as the contemporaneity of individual residential units, and spatio-temporal variability in communities.

The dry stone masonry house foundations of the Marquesas Islands provide a useful case study into how varied social and natural processes might influence residential architecture. Perhaps most importantly, early contact period sources suggest that most, if not all, permanent dwellings were situated on some kind of stone foundation, usually a platform or terrace known as a *paepae hiamoe* (literally, "sleeping platform"), regardless of the social standing of the occupants (e.g., Crook 2007; Forster 1777; Langsdorff 1968; Marchand 1801; Stewart 1833 : 209). At the same time, house foundations varied in area, height, construction materials, and other elaborations (such as use of exotic stones and carvings), variability which at least in part reflected the status of past occupants. Raised house foundations also are widely distributed throughout the archipelago today, being found on all the major islands and in nearly every habitable valley, yet apparently they were not used by the earliest Marquesan settlers. As highly visible elements of the archaeological landscape, they are readily identified and recorded.

Not surprisingly, given these characteristics, Marquesan house foundations are moderately well studied. They have been used to track settlement distributions and layout (Kellum 1968, Ottino 1986), population size and ecological relationships (Bellwood 1972; Conte and Maric 2007), socio-artistic interactions (Millerström 2001), and patterning in relations to economic facilities (Addison 2006).

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Problematically, however, very few domestic foundations have been dated, this despite the prominent role architecture is assigned in the five-phase cultural historical sequence put forth by Robert Suggs (1961) nearly 50 years ago. This has left open not only the timing of domestic architectural change, but also questions of contemporaneity and occupation duration.

The present analysis makes some progress toward rectifying this situation. Systematic survey in Anaho Valley on the northeastern coast of Nuku Hiva Island has resulted in an inventory of over 300 dry stone masonry structures. Roughly one-third of these are interpreted as domestic house foundations, based on formal similarities with ethnographically documented residences, their size, and spatial relations (e.g., relatively isolated structures that are not part of large complexes). Excavation and radiocarbon dating both in occupation areas that lack architecture, and adjacent to structural features, allows for construction of an absolute chronology for the appearance of raised house foundations in particular. The radiocarbon chronology is supplemented by various relative dating measures, including assessments of stratigraphic relations and the presence of temporally diagnostic artefacts and ecofacts. The Anaho findings are compared with dated domestic structures elsewhere in the archipelago, a limited but nonetheless geographically dispersed dataset. The newly developed chronology of domestic architecture allows for consideration of how these features articulated with other social and natural processes.

ENVIRONMENTAL, CULTURAL AND ARCHAEOLOGICAL BACKGROUND

Environment

The Marquesas Islands lie at the northeastern margin of central East Polynesia and, at c. 500 km from their nearest neighbors, are relatively isolated. The ten main volcanic islands vary in size from 1.3 to 330 km^2, Nuku Hiva being the largest (Brousse et al. 1978) (Fig. 1). Human colonization is currently placed between the eighth to eleventh A.D. centuries (Fig. 2; based on Allen 2004; Anderson and Sinoto 2002; Rolett 1998). In many respects, the archipelago was a challenging environment for early Polynesian settlers. The islands are generally rugged and mountainous, and coastal plains often small and narrow. Marine environments also were limited relative to islands in the west; steep cliffs dominate most coastlines, and boulder and sand beaches are restricted to valley mouths. Further, near-shore waters are typically deep, shallow submarine platforms lacking, and coral reefs both uncommon and small.

Local climate conditions presented further challenges. The group lies within the equatorial tropics and variability in rainfall is dramatic, with annual averages varying from 700 mm in leeward areas, to nearly 1500 mm on windward coasts (Addison 2006; Allen 2010; Cauchard and Inchauspe 1978). Although drought conditions were emphasized by early historic observers, it was the oscillation between extreme droughts and torrential rains that probably most strongly affected Marquesan society over time (Allen 2010). El Niño conditions in particular sometimes brought torrential downpours (Naval Intelligence Division 1943:265; Salinger and Lefale 2005), as for example during 1982–1983 when one leeward station received over seven times the monthly average (Ferdon 1993:4). These

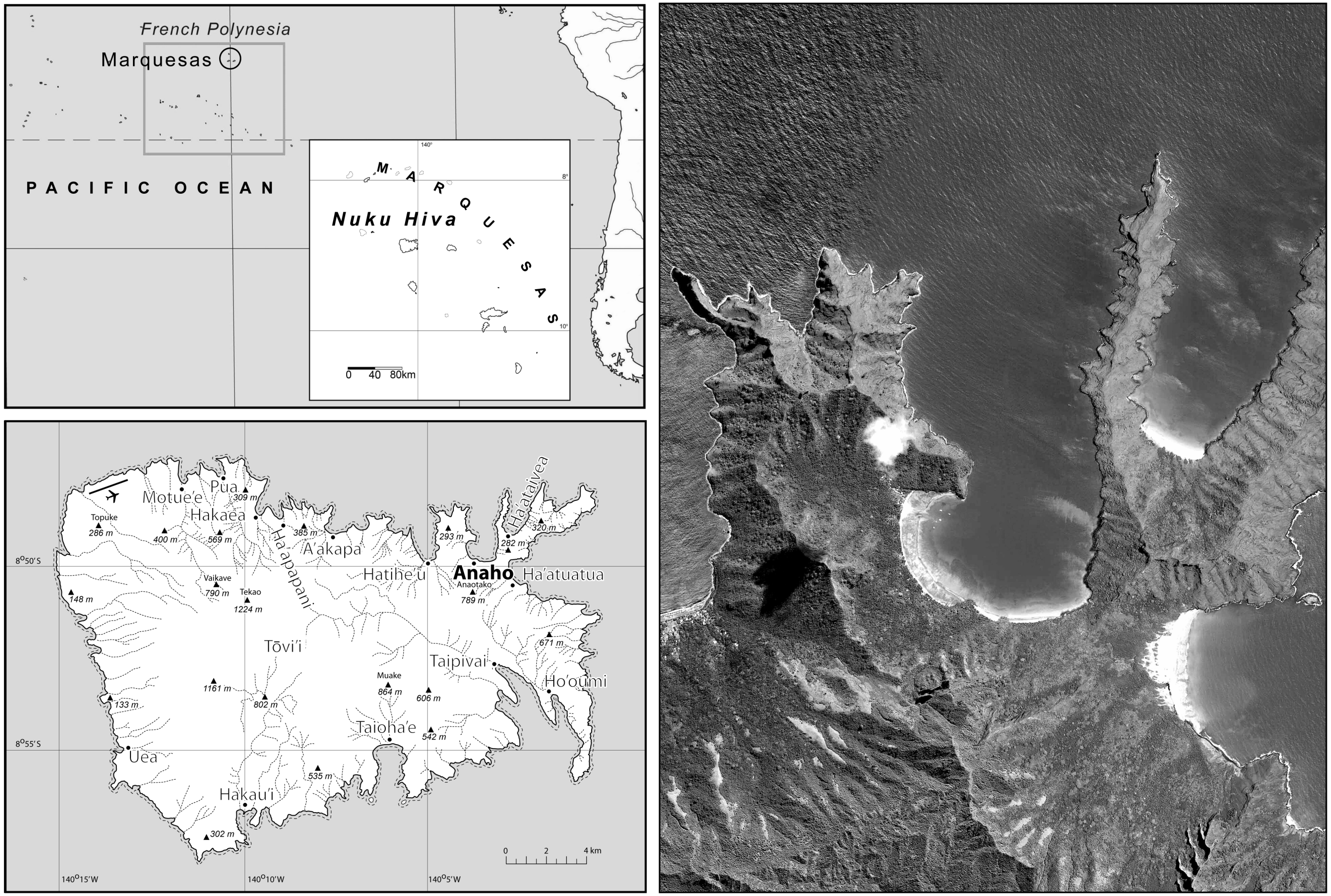


Fig. 1. Nuku Hiva Island and IKONOS satellite imagery of Anaho Valley.

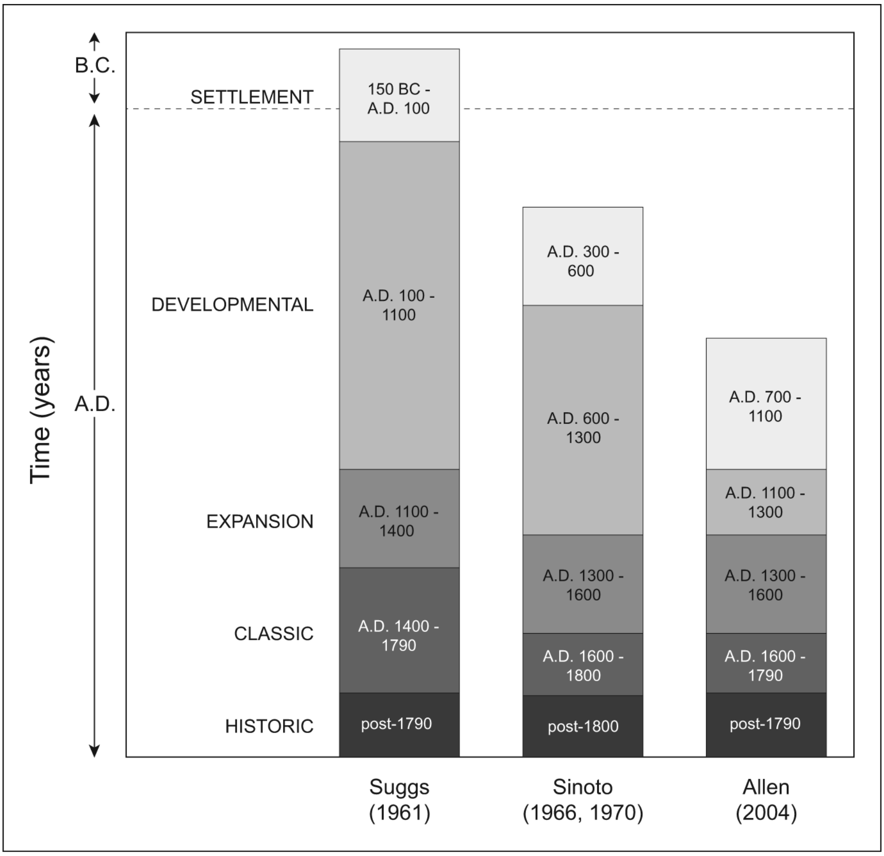


Fig. 2. Changing ideas about the chronology of the Marquesan cultural sequence (from Allen 2004).

deluges are often accompanied by flooding and discharge of sediments into near-shore areas, and rivers often remain high for extended periods (Naval Intelligence Division 1943).

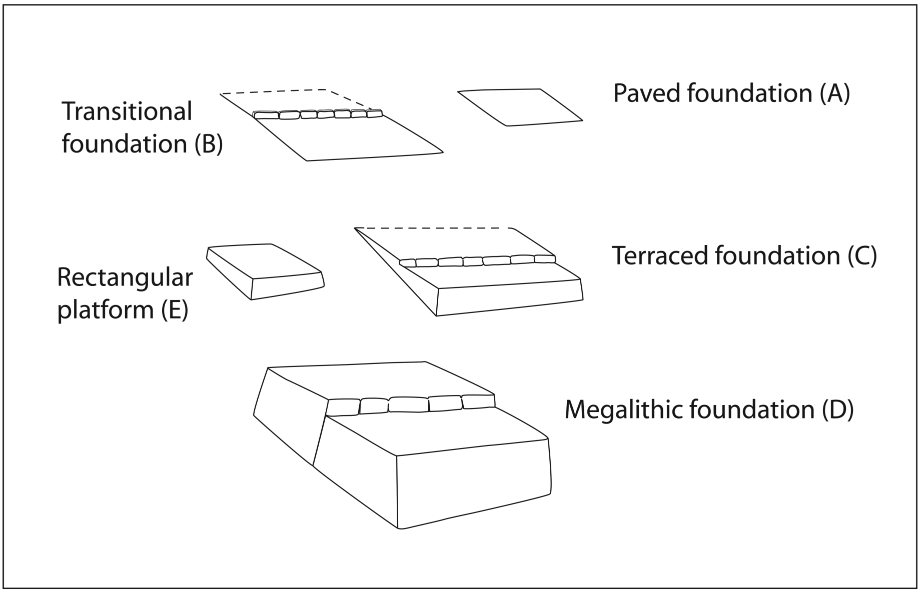
The rugged topography potentially hindered inter-valley travel and over time may have impeded sociopolitical integration (see below). However, geochemical analysis of stone tools demonstrates that geographically restricted stone resources flowed between the northern and southern groups up until c. A.D. 1450 (Rolett 1998). While exchange in stone items apparently diminished after this time, at western contact indigenous commerce in tumeric, bark-cloth, hogs, ornaments, canoes, salt, and occasionally even adzes was observed (Åkerrén 1983; Brown and Brown 1931 : 14; Crook 2007 : 126; Handy 1923; Robarts 1974 : 119, 148), with goods traveling the length of the archipelago. Relevant to the current analysis is the evidence for some form of inter-island communication throughout prehistory, suggesting ideas could have been transmitted between islands with some ease. At the same time, the rugged topography may have created strong geographic patterning in the directions of social interaction, patterning that may be useful in attempts to discern the underlying causes of morphological variability in domestic structures (see below).

Cultural Background

At western contact, the indigenous population may have numbered around 43,000 (Rallu 1990). Europeans observed that Marquesan polities were typically single territorial groups occupying individual valleys, although some tribes were more widely dispersed. Supra-tribal coalitions were occasioned, as on Nuku Hiva, but only 'Ua Pou was under the control of a single paramount (Handy 1923). Relative to other Polynesian archipelagos (Kirch 2000), Marquesan chiefs had lost considerable political, religious, and economic ground over the course of prehistory (Allen 2010; Goldman 1970; Kirch 1991; Thomas 1990). Political and economic power was vested in individuals through both hereditary rights and demonstrated abilities. Moreover, the ritual prerogatives of hereditary chiefs had been relinquished to shamanistic priests, sometimes kin relations and other times not; in some cases priests held authority over even larger geographic areas than chiefs (Thomas 1990). Additionally, at least some property had become privatized and was held by individuals "unqualified by status or rank position" (Goldman 1970). Overall, status and power relations were dynamic, fluid, and mutable; political agency was key and stemmed from leadership skills, generosity (especially of food), manipulation of social relations, professional accomplishments, and charisma (Allen 2010; Dening 1980; Goldman 1970; Thomas 1990). Thomas (1990), building from his detailed ethnohistoric analysis, suggests successive ecological crises might have undermined chiefly authority and destabilized traditional power relations, while Kirch (1991; also Suggs 1961) looked to linkages between population growth, environmental constraints, and agricultural intensification, suggesting these processes brought new opportunities for social transformation. Domestic architecture, highly visible and widely distributed, is potentially an important proxy measure of such changes, highlighting the importance of establishing a robust chronology.

Marquesan valleys are roughly of two forms. One group consists of broad amphitheater-shaped basins like Anaho, Hatiheu, and Taioha'e on Nuku Hiva (Fig. 1) which offered relatively generous expanses of gentle slopes for settlement. A second group, long, narrow, and steep-sided, led communities to cluster on the narrow coastal flats, alongside streams and rivers, and on the lower valley slopes. Examples of this latter group include Haka'ohoka, 'Ua Pou (Ottino 2008), and Taipivai on Nuku Hiva. Valley form potentially influenced not only settlement patterning, but also aspects of local architecture.

At European contact, Marquesan houses followed a fairly regular plan, varying mainly in size, height, and degree of elaboration. The archetypical house foundation was rectangular in plan and raised on three to four sides, with a step or raised section along the backside (Fig. 3, inset) (historic sources summarized in Ferdon 1993; see also Handy 1923; Linton 1923; von den Steinen 2005). In elite homes, this upper step might be faced with red or gray tuff, stones that often came from distant quarries. Ethnohistoric accounts suggest house sizes varied considerably, but both commoner and elite houses were typically reported as being around two



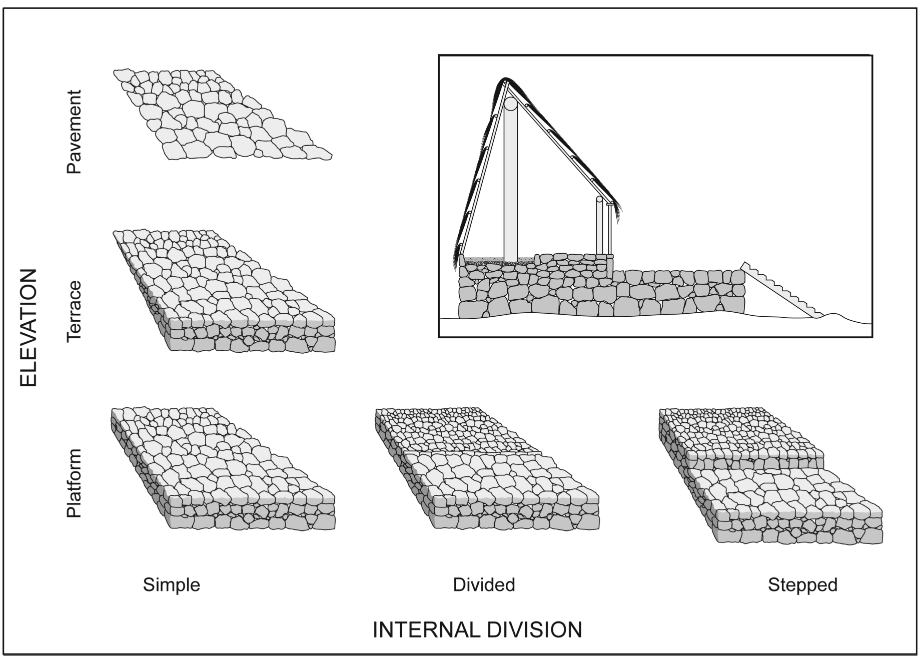


Fig. 3. a: Suggs' (1961) original typology (A–D) of house foundations (*paepae*); b: an alternative paradigmatic classification of foundation morphology, with five out of nine possible classes illustrated; inset: example of Contact-period domestic residence, based largely on von den Steinen (2005), with placement of the main structural posts shown in Nuka Hiva style (Linton 1923 : 277).

to four meters in width and three to eight m in length (Bellwood 1972 : 7; Ferdon 1993 : 21), although Crook (2007 : 78) estimated some were over 30 m long.

The thatched superstructure, itself an impressive edifice of up to 3 m, sat atop this upper step, looking out onto a typically uncovered veranda-like area (the *pa'ehava vaho*) (Fig. 3, inset in lower illustration). The stepped interior portion of the foundation might be further subdivided lengthwise, with the paved forward half being used for domestic activities and the rear section covered in grass and mats set between two parallel coconut logs and used for sleeping. An unusual feature of the Marquesan house was the lack of a rear wall, a function served by the roof, which extended from the ridge pole to the ground, or sometimes the edge of the platform. The front house posts might be ornamented with white barkcloth overlain by colored cordage (Crook 2007). Linton (1923) indicates some were carved, although this could be a post-Contact innovation (Ferdon 1993 : 23). The roof was usually thatched with breadfruit leaves, but *Pritchardia* palm leaves were prized and when bleached by the sun were said to "gleam among the groves, in the brightness of the day, like neatly whitened cottages" (Stewart 1833 : 211).

Houses were presumably constructed as the need arose, however Handy (1923 : 150) indicates they were often built to commemorate births, particular the arrival of first-born sons. One of the most impressive structures observed by Suggs (1961 : 161) was constructed in 1870 by a Hatiheu chief to honor the arrival of his granddaughter. Langsdorff's (1968 : 127) account of "country" homes which could be easily taken apart, suggests a degree of residential mobility and at least occasionally the maintenance of multiple residences by the elite. As for house abandonment, Handy (1923) reported that some houses were burned when the occupant died and Linton (1923 : 14) noted that veranda pits were sometimes used as burial crypts (see also Suggs 1961), although both practices might be post-Contact and related to epidemics. The foundations were apparently usually left intact and sometimes re-occupied (e.g., Crook 2007 : 109), with some still in use today. Archaeological evidence also provides examples of partial structure dismantling and re-use of stones (e.g., Bellwood 1972). These brief ethnographic notes raise a number of site formation issues, ones that are only cursorily dealt with here but ultimately will be important to demographic reconstructions and analyses of community organization.

Cultural Historical Sequence

Archaeological interest in the islands dates to Ralph Linton's (1925) 1920–1921 visit as a member of the Bayard Dominick Expedition. His initial observations "showed that little material or information was to be gained from excavation" and he concluded that the islands "offered few opportunities for archaeological research" (Linton 1925 : 3). Linton (1923, 1925) turned his attention to the archipelago's spectacular public structures (*tohua*), religious/mortuary (*me'ae*) complexes, and their associated sculptures, an interest many have continued today (e.g., Chavaillon and Oliver 2007; Ottino-Garanger 2006).

Linton's study was followed by Robert Suggs' (1961) island-wide investigation of Nuku Hiva. Suggs explored multiple localities, including the large valleys of Taipivai and Hatiheu. Altogether 21 sites were identified and tested, 12 of which were architectural. Like Linton, Suggs focused on the often large public architecture (*tohua*). Domestic house foundations and structures associated with inspirational priests, religious rites, and mortuary practices (*me'ae*) received less attention. Suggs' research made significant advances on that of Linton in that he carried out stratigraphic excavations, collecting large numbers of artefacts and in some cases, gathering information on structural building sequences. Using a combination of radiocarbon dating (a method that was relatively new at the time), artefact seriations, and stratigraphic relations, Suggs developed a five-phase cultural historical sequence for the group (Fig. 3, upper illustration). This sequence was innovative for the time in its inclusion of not only artifact forms but also sociopolitical and demographic processes. Suggs built an engaging and detailed narrative of historical change around this framework. However, as archaeological research in the archipelago continues, and new technologies not available to Suggs are applied, some aspects of this narrative are increasingly in question (e.g., Addison 2006; Allen 2004; Rolett 1998; Sinoto 1966, 1970).

Most controversial have been Suggs' ideas about the antiquity of human settlement in the group. In his original study, he analyzed ten radiocarbon samples from three rockshelters and one open site; no radiocarbon samples were secured from architectural features (Suggs 1961:20, 67). He anchored the early end of his sequence with two dates (reported as 2080 ± 150 and 1910 ± 180 in his Table 1) from the open settlement at Ha'atuatua Beach. Here he had uncovered a complex stratified sequence with stylistically early artefact forms. Suggs' early dates were first challenged by Sinoto (1966, 1970) whose excavations at Hane, 'Ua Huka and subsequently at Ha'atuatua led him to conclude that the Marquesan sequence was a few hundred years shorter (see Fig. 2). More recent excavations at Ha'atuatua by Rolett and Conte (1995) further suggest that Suggs' earliest Ha'atuatua dates are inaccurate estimators of first use of this locality. In 2004, Allen proposed an even more compressed sequence for the archipelago (Fig. 2) based on the foregoing, other recent excavations, re-dating of other key sites (Anderson and Sinoto 2002), and new evidence from the region at large. While we are now fairly confident that human arrival in the group post-dates Suggs' original age estimates by several centuries, the chronology of other cultural processes remains poorly controlled.

A second cornerstone of Suggs' cultural historical sequence was his artefact seriations, a relative measure that was central to his dating of post-settlement processes. These too have been challenged vis-à-vis their chronological value. Suggs used changing abundances of different fishhook and coral abrader forms as relative dating measures. However, in constructing his seriations the possibility that variability in fishhook morphology might represent different functional solutions aimed at particular species of fish or microenvironments, rather than temporally variable styles, was overlooked (Allen 2003). The coral abrader seriations also were problematic, as there is the strong likelihood that such tools acquire their distinctive morphologies through use (Allen 1992:218–219), an issue Suggs (1961) himself recognized. Different forms may thus represent different stages in the use-life of a generalized tool, rather than temporally significant types. These issues aside, there is the further problem that his fishhook and abrader seriations in large part fail to meet some important formal conditions of the seriation model (see discussion in Allen 2003; also Dunnell 1981). While it is clear that there are some diagnostic early artefact forms in the Marquesas Islands, as for example, whale tooth pendants, reels, and harpoons (Sinoto 1966, 1970), Suggs' formal seriations of fishhooks and coral abraders, and his attempt to use them as fine-grained relative dating measures, is problematic.

A third key component of Suggs' chronology was his typology of architectural foundations (Fig. 3, upper illustration). In the main, this typology was based on the principle of increasing morphological complexity. In Suggs' view, early Marquesan houses were simple ovoid pole structures with unpaved floors (1961 : 181), a form he suggested was represented at the early open settlement on Ha'atuatua Beach. He argued that the transition to stone pavements (his "paved *paepae*") began in the second half of his lengthy Developmental Period (A.D. 100–1100). These were followed by "transitional *paepae*" where the interior area was differentiated from the front pavement or veranda by a stone alignment, a form said to first appear in the middle Expansion Period (A.D. 1100–1400). Raised stone foundations (his "terraced *paepae*") were assigned to the very late part of the Expansion Period, while "megalithic *paepae*" were built in the middle and late Classic Period (A.D. 1400–1790), and occasionally in the Historic Period (post-1790 A.D.).

Problematically, the absolute age estimates for these transitions are speculative in that no architectural features were radiocarbon dated. Further Suggs' chronological sequence characterizes architecture generally, without entertaining the possibility that morphological changes in domestic versus community structures might have been independent, occurring at different times, and in response to different conditions. With respect to domestic structures, only one set of well-excavated foundations (NT-8 in Taipivai Valley) was reported and here there was considerable evidence for post-Contact usage, possibly indicating a late construction age. Minor excavations elsewhere (e.g., Uea Valley) may have figured into his interpretations but they are only briefly described (Suggs 1961 : 25) Although Suggs (1961 : 52) points out "it is impossible to establish any sequence for this site [NT-8] because superposition occurs only at P-D where that structure was built on the long, low terrace that may or may not have been previously used as a house floor," he goes on to assign initial construction of this residential compound to his late Expansion Period. Finally, domestic architecture is reputed to have reached its culmination in the late Classic Period (A.D. 1400–1790) when large "megalithic" platforms appeared, although, again, none of these structures were radiometrically dated.

As the foregoing intimates, Suggs' typology of architecture, while an apparently logical sequence of morphological change, is not supported by absolute dating or, in the case of domestic structures, unambiguous stratigraphic sequences of construction. The present analysis is aimed at gaining a better understanding of the chronology of domestic architecture and morphological variation across time in the Marquesan context. As a first step, I suggest that Suggs' typology of foundations be replaced with a more systematic and less ambiguous paradigmatic classification. Paradigmatic classifications are a parsimonious means of creating analytical units whereby classes are formed by the intersection of different variables or attributes (Dunnell 1971). Each class is defined by the same set of variables, and modes (or values) are both un-weighted and mutually exclusive. The classification provided here considers the intersection of two variables, the elevation of the structure in relation to the ground surface (no sides raised, one to three sides raised, or four sides raised) and the nature of the internal division (absent, present but not raised, or stepped). The classification allows for the possibility of nine classes, five which are illustrated here (Fig. 3, lower illustration). It moves away from Suggs' ambiguous terminology which, for example, intimates that only Type E foundations are rectangular and defines Type B foundations in chronological rather than morphological terms. The latter is important as some apparently historic domestic foundations (see below) are quite similar to his prehistoric "transitional" forms. The alternative paradigmatic classification has utility not only for the Anaho Valley analysis but for description of Marquesan domestic architecture generally. Usefully new variables can be added without damaging the integrity of the original classification, as each variable is mutually exclusive. The current classification relates only to the most general features of house foundations and a variety of other attributes could be considered in future analyses.

ANAHO STUDY SITE

Anaho is a wide, amphitheater-headed valley, which opens onto a deep, relatively protected bay (Fig. 4). Two perennial springs provide surface water on a year-round basis and associated streams flow intermittently. Microclimatic variation is marked, with the northern sub-valley being fairly dry, while a commanding 789 m peak (Fig. 4) channels a modest amount of rainfall into the southern sub-valley. These ecological differences are registered in the valley's agricultural features, with dryland terraces on the northern slopes and irrigated ones to the south. The area of the valley suitable for habitation and cultivation is around 78 hectares. Although small compared to neighboring Hatiheu Valley, it exceeds the most densely occupied area of Hane Valley on 'Ua Huka (25 hectares) (Kellum 1968) and the habitable land of Hanatekau Valley on Hiva 'Oa (30 hectares) (Bellwood 1972), two other localities where domestic structures have been analyzed in some detail. Further, Anaho has two additional resources that may have been important economic assets in the past. Nuku Hiva's largest coral reef is found here (Brousse et al. 1978) and was a source of not only favored foods, but also pearl-shell (*Pinctada margaritifera*), an important raw material for fishhooks, ornaments, coconut graters, and tattoo needles. Anaho's second restricted resource is a relatively fine-grained stone, of a quality suitable for adze manufacture (Allen and McAlister in press). The role of these resources in Anaho's economic and political position vis-à-vis other Nuku Hivan valleys is currently under investigation. Most relevant to the current analysis is that Anaho is neither particularly large nor small, and it is neither especially resource poor nor rich; rather, it is a fairly typical mid-sized Marquesan valley, with modest agricultural lands, and at least two specialized resources.

One of the first specific accounts of Anaho comes from Captain David Porter (1822:31) who in 1813 found the valley occupied by two "great tribes," presumably one in each sub-valley, a situation consistent with the archaeological patterning. By the mid-nineteenth century, however, only a single tribe remained (Rollin 1929:69), raising the possibility that introduced Old World diseases and drought-induced famines, which decimated Marquesan communities in the late eighteenth to early nineteenth centuries (Dening 1980; Robarts 1974), may also have affected Anaho. By the early 1800s, the tribes of Anaho were allied with

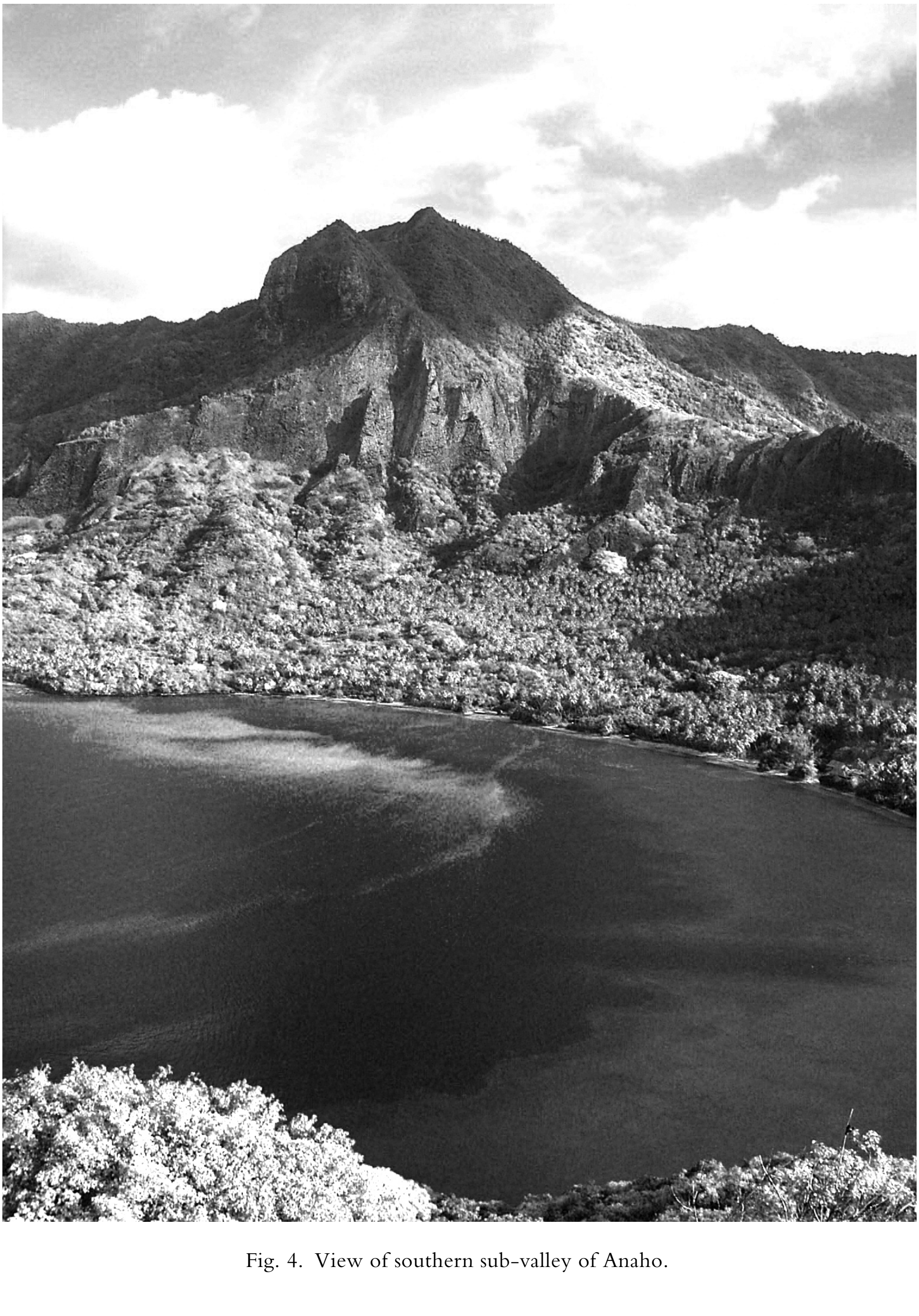


Fig. 4. View of southern sub-valley of Anaho.

neighboring Hatiheu Valley, with men from the two areas mounting an attack on 'Ua Huka Island around the turn of the century (Kellum 1968:203). These ties persisted into the 1880s, with accounts indicating Chief Ko'oamua of Hatiheu (leader of the 'Atikea Tribe) controlled certain Anaho resources (i.e., manta rays), maintained a sizable residence on Anaho's coast, and politically overshadowed the younger local tribal leader (Balfour 1903:80; Stevenson 1987). Whether or not Anaho was initially an independent polity, which came under the political control of its larger neighbor in the contact period, is uncertain.

Excavations at Teavau'ua

Some of the earliest occupational deposits in Anaho have been identified on the northern coastal flat, an area known as Teavau'ua (AHO-1). Coring, shovel pits, and controlled excavations at this location have revealed a fairly uniform stratigraphy, with three cultural layers spread across an area at least 200 by 300 m (Allen 2004). Five radiocarbon determinations place the basal occupation (Layer IV), associated with ephemeral use of the coast for fishing, adze manufacture, and fishhook production, in the period A.D. 1160–1400 (2σ range) (Fig. 5). The AMS determination on OZI-974, a short-lived nutshell sample, is considered the best age estimator for this occupation, producing a 1σ age range of A.D. 1250–1295. Although pene-contemporaneous sites elsewhere in the archipelago indicate flagstone-style pavements were part of some early residential structures (Conte 2002; Rolett 1998; Sinoto 1966), to date no stone architecture other than a dubious gravel "pavement" has been identified in this early context at Anaho.

The subsequent occupation at Teavau'ua was more permanent in character and dates to A.D. 1320–1670 (2σ range) based on another five radiocarbon determinations, with the most likely period of occupation between A.D. 1400 and 1650 (Fig. 5, Layer IIIb). Not only was occupational debris more plentiful in this layer,

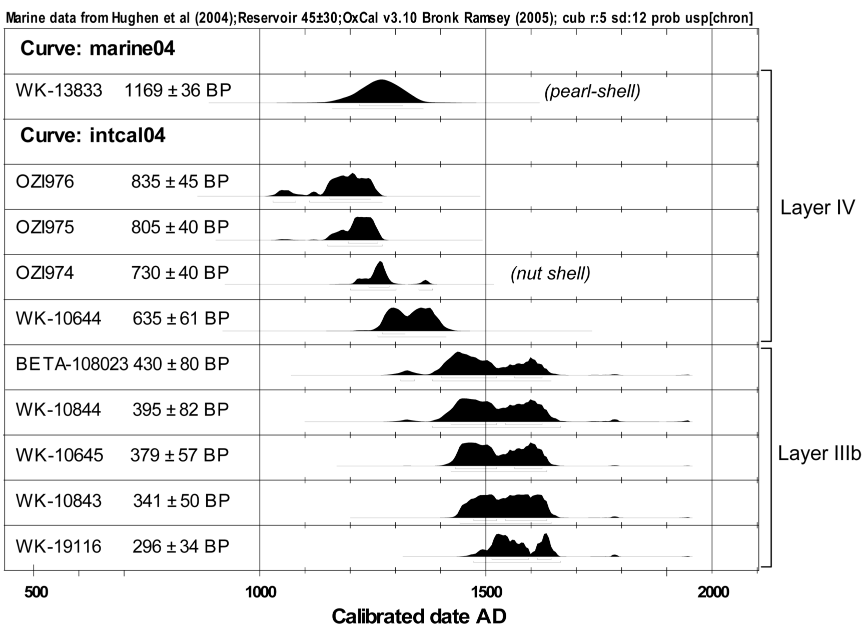


Fig. 5. Radiocarbon chronology of stratified coastal site Teavau'ua (AHO-1), Anaho Valley details in Allen (2004) and Petchey et al. (2009).

but *in situ* features (hearths and postmolds) also were prominent. Once again, neither stone pavements nor raised house foundations have been identified thus far. This could reflect regional variability in domestic structures, or be an artefact of sampling, but it is also possible that pavements were uncommon, being limited to elite residences and specialized structures.

The uppermost cultural layer (IIIa) at Teavau'ua dates to the late nineteenth century, as indicated by historic period artefacts, remains of historically introduced animals, and a single radiocarbon date (Fig. 5). Overall, the Teavau'ua coastal excavations suggest that early use of the valley, from the thirteenth through sixteenth centuries, was not associated with dry stone architecture. The Teavau'ua coastal flat findings are particularly important in light of subsequent excavations elsewhere in the valley, carried out to establish the age of raised house foundations.

Architectural Study

To characterize the valley's traditional architecture a systematic survey was undertaken covering an area of roughly 0.78 km^2. Along with stone house foundations, structures identified to date include wet and dry agricultural features, stone flaking areas, a defensive lookout, probable animal enclosures, burials, and religious structures of varied sizes and kinds. Although architecturally elaborate community structures (*tohua*) have not been observed, three specific areas with minimal architecture have been identified by local informants as *tohua*. Of the 300-odd known structures, nearly one-third are rectangular foundations. Most spatially discrete rectangular foundations are likely to be domestic structures but some could be men's houses, small shrines, and other special purpose structures (Handy 1923; Linton 1925). While it is not possible to easily differentiate between these possibilities on surface evidence alone, it is likely that these specialized structures were rare and at least some shrines were quite small (Linton 1925). Consequently most of the raised stone foundations found in Anaho are interpreted as domestic house foundations. If very small foundations (those under 9 m^2) are excluded from the Anaho series, on the grounds that they would have been too small for permanent habitation by a family, then the number of probable domestic structures identified to date is 87.

Raised foundations are widely distributed across the catchment, from the coast up to c.125 m (Fig. 6). They vary considerably in size and complexity, from small, simple pavements, platforms and terraces (Fig. 7), to very large complex structures (Fig. 8), with the full range of forms identified by Suggs (1961) being represented. They occur in varied topographic settings, ranging from the coastal flat, to level ridge-tops, to strongly sloping areas.

The sample of domestic foundations found at Anaho is dominated by stepped terraces and platforms (see Fig. 3, lower illustration), the form of house foundations most commonly described in the ethnohistoric literature (e.g., Crook 2007:79; von den Steinen 2005). The overall surface areas of these foundations vary from 12.3 to 174 m^2 with a mean of 61 m^2, although the majority (60%) are between 20 and 60 m^2. By way of comparison, in Hanatekua Valley, Hiva 'Oa, Bellwood (1978) recorded a mean area of 32 m^2 for simple un-stepped foundations and 73 m^2 for stepped ones (skewed by one very large structure).

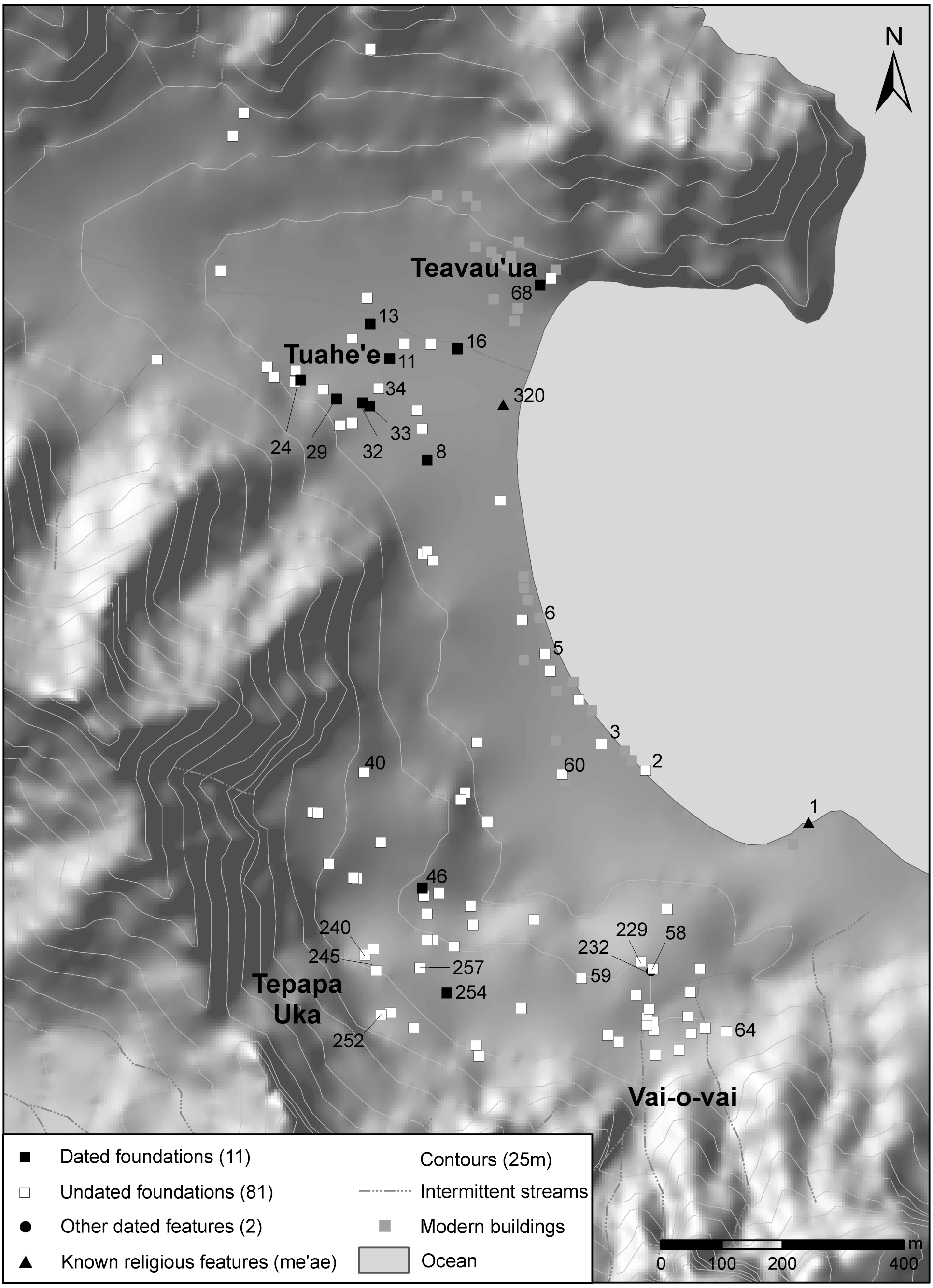


Fig. 6. Distribution of foundations in Anaho Valley.

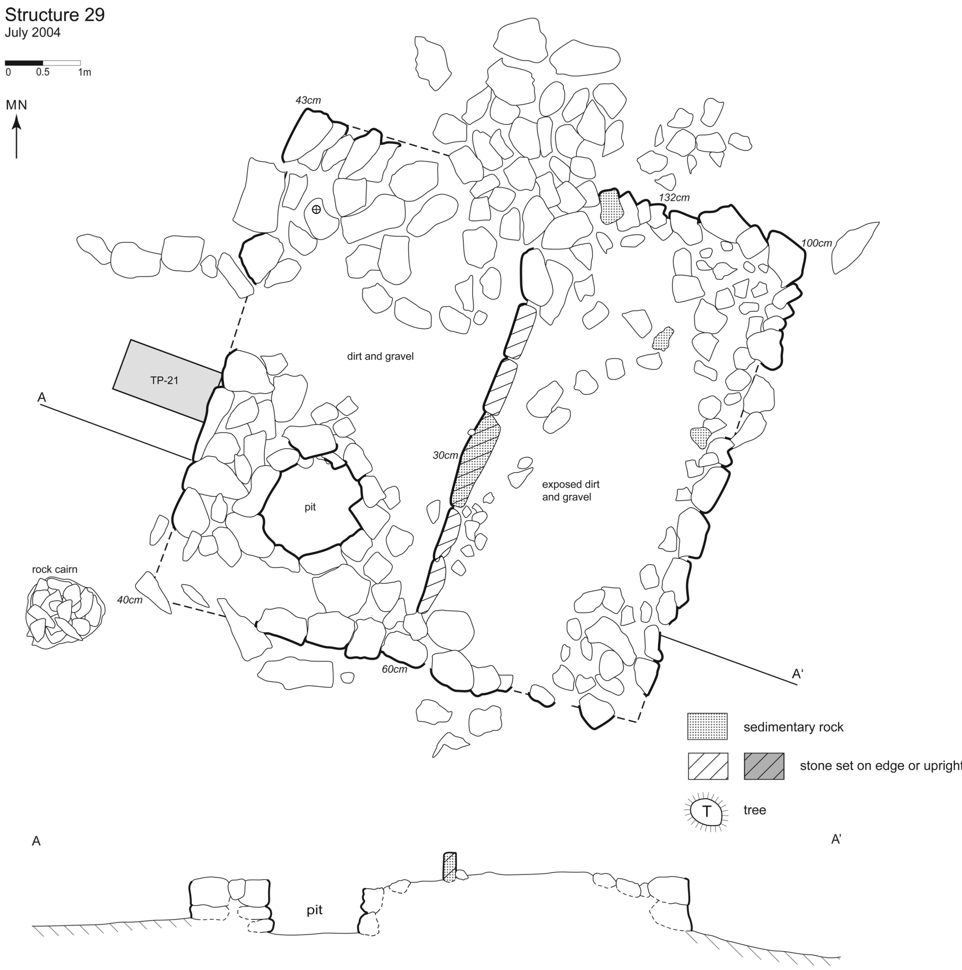


Fig. 7. Plan view and cross-section of small stepped platform, Structure 29.

Roughly half of Kellum's "house sites" (many which were terraces with a forward pavement and an unpaved rear section) were under 30 m^2, although stone platforms (her "raised *paepae*") averaged 57 m^2. Addison (2006 : 214), working in the 'Atikea sector of Hatiheu Valley, recorded 54 structures with an overall mean foundation area of 72 m^2, while stepped foundations alone averaged 77 m^2. Ottino (1986 : 186) suggests that structures in Haka'ohoka, 'Ua Pou, were around 85 m^2. If ethnohistoric accounts of houses (see above) are assumed to exclude leading verandas (Bellwood 1972 : 7), and widths are doubled to roughly account for this feature, then the typical contact period examples range in surface area from 12 m^2 to 64 m^2.

Only 11 of the 87 Anaho structures exceed 100 m^2, consistent with the idea that while both commoners and elites utilized stone foundations and those occupied by the latter were differentiated by size and other characteristics. Similarly, at

Fig. 8. Large stepped platform, Structure 11.

Hanatekua 11 of the 74 domestic structures exceeded 100 m^2; one exceptional structure covered an area in excess of 411 m^2 but the next largest structure was only 208 m^2 (Bellwood 1972). The largest structure in Addison's (2006) survey area was 209 m^2, while at Hane only 8 structures out of 108 structures exceeded 80 m^2, the largest being 140 m^2 (Kellum 1968 : 61, 67). With the largest structure at 174 m^2, Anaho again occupies an intermediate position. These comparisons demonstrate that the Anaho foundations are intermediate relative to those recorded elsewhere in the archipelago, in terms of average sizes, proportions of large structures, and maximal structure sizes.

The larger, presumably elite structures at Anaho are frequently distinguished by massive façade stones, some measuring up to 2 m across (Fig. 8). Similarly, the use of transported stones (such as red volcanic tuff) for step risers and less frequently foundation façades, was limited to a small number of structures (Fig. 9), suggesting only the elite could afford their acquisition and transport. These aspects of morphological variability will be considered elsewhere in more detail (e.g., Allen 2008).

For the express purpose of dating the valley's architecture, small-scale excavations were carried out at 22 localities, following the protocol outlined in Table 1 to the extent possible. An effort was made to sample structures of varied morphologies and from different parts of the valley (inland versus coastal locations, northern versus southern sub-valleys). Typically test pits were placed flush

Fig. 9. Plan view and cross-section of large divided platform with red tuff step risers, Structure 2.

against foundation stones and excavations carried to the sterile substratum (e.g., Figs. 10 and 11). One difficulty encountered was that sediment accumulation in some areas was quite limited, with rocky ground predominating and unambiguously associated charcoal lacking. In other areas, soils were present but cultural deposition was apparently minimal, with little charcoal, few artefacts, and infre-

TABLE 1. PROTOCOL FOR RADIOCARBON DATING OF STONE ARCHITECTURE

1. Excavation units placed flush against foundation stones, so as to unambiguously source radiocarbon samples to layers stratigraphically associated with structures or, to layers that are stratigraphically below structures.
2. Both associated and underlying stratigraphic contexts sampled whenever possible, to more accurately determine timing of construction.
3. In situ burn features sampled whenever possible, to preclude possibility of dating intrusive materials (see also Kahn 2006).
4. Radiocarbon samples taxonomically identified so as to exclude long-lived species.
5. Short-lived plant species selected to improve dating precision and accuracy, such as coconut (*Cocos nucifera*) and candlenut (*Aleurites moluccana*) endocarp, *Pandanus* keys, twigs, or grass stems in the case of charcoal, or suspension feeders in the case of shellfish (Petchey 2009; see also http://www.radiocarbondating.com/imagesOMR/homepageframe.html)

quent faunal remains being recovered. In these contexts, samples suitable for radiocarbon dating were limited.

The radiocarbon samples acquired from the foregoing tests are of two kinds. One set (Fig. 12) includes materials recovered from occupation layers (and when possible fire features within these layers) stratigraphically associated with structure foundation stones and assumed to represent sediments accumulated while the structures were in use (e.g., OZI-978 in Fig. 11). The second set of samples (Fig. 13) derive from strata below basal foundation stones (e.g., WK-16728 and OZI-979 in Fig. 11); these are assumed to relate to activities that pre-date construction and thus provide maximal ages for the overlying structures. In all cases, an attempt was made to identify the sample components. In the early stages of this project, the potential for in-built age in tropical Pacific trees was not fully appreciated and a range of taxa were submitted for dating. However, recent work elsewhere (Allen and Wallace 2007) and ongoing analyses of samples from Anaho suggest that some local hardwoods are long-lived and can bias estimations of site age. *Cordia subcordata* appears to be particularly problematic, as illustrated by the two determinations from Structure 13, where the stratigraphically superior determination (on *Cordia* charcoal) is older (Table 2). Brown and Brown's (1931) illustration of a massive Marquesan *Cordia* tree also illustrates the potential for this species to be long-lived. Consequently, the more recent Anaho analyses have been made on demonstrably short-lived materials (e.g., coconut shell) in combination with AMS analyses whenever possible.

The radiocarbon contexts and results are detailed in Table 2. In the case of six structures, unambiguous stratigraphic associations could be made between stone foundations and dated materials; in all instances, the age ranges indicate post-1640 A.D. construction dates. Three of these (Structures 16, 13, 68) are located on flat land on or near the coast, while another three (Structures 24, 29, 46) are found in more interior areas. In three cases (Structures 8, 242, 245), excavations could not be placed flush against the foundation stones. However, units in close proximity to the raised foundations uncovered fire features and cultural deposits that appeared to be contemporary with structure use on stratigraphic grounds; in all three cases samples yielded post-1640 determinations. At Structures 16 and 68, the late dates associated with the architecture are corroborated by additional samples from underlying strata with late prehistoric age estimates.

Fig. 10. Excavation at front of Structure 254; photo pole is resting on support stones associated with the platform's boulder façade.

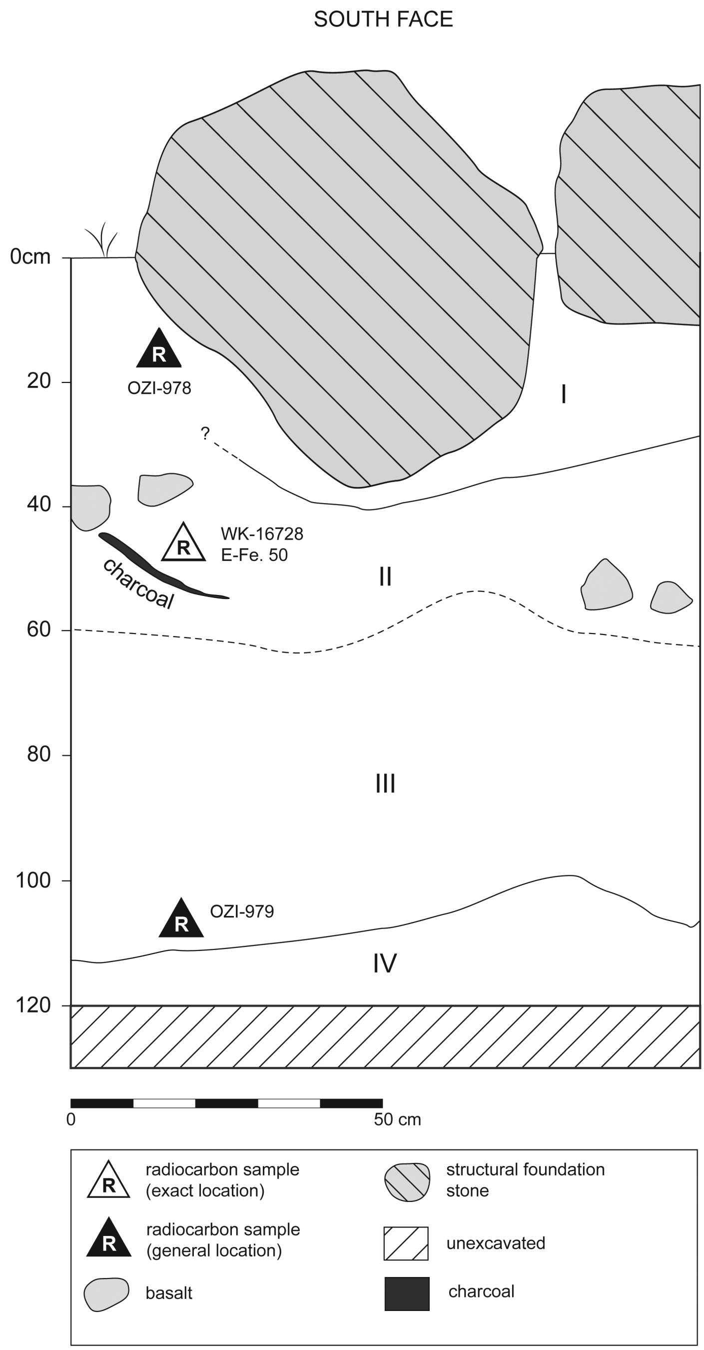


Fig. 11. Profile of excavation unit at Structure 16 showing location of radiocarbon samples.

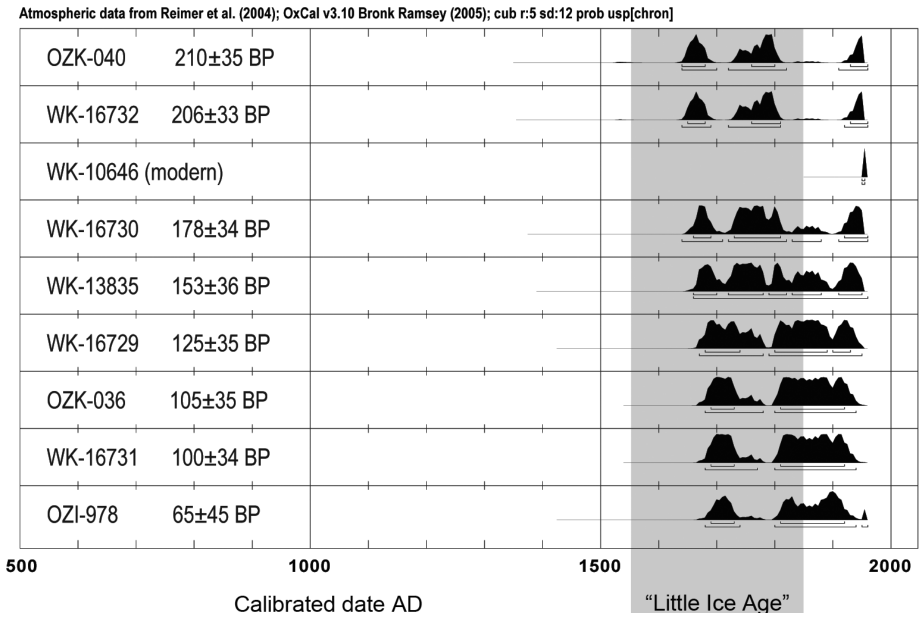


Fig. 12. Radiocarbon samples directly associated with surface architecture.

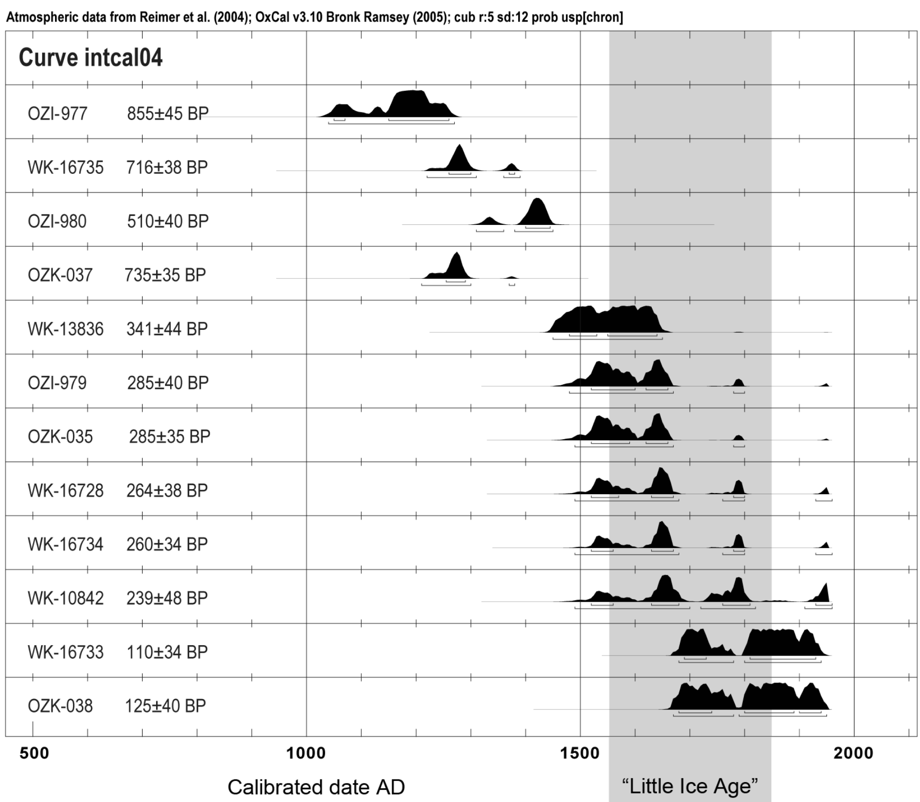


Fig. 13. Radiocarbon samples from strata below surface architecture.

TABLE 2. DETAILS OF RADIOCARBON SAMPLES ASSOCIATED WITH ARCHITECTURE

LAB NO.[1]	STRUCTURE NO.	STRUCTURE MORPHOLOGY[2]	LOCALITY	AREA (m^2)	UNIT	LAYER	COMMENTS	MATERIAL[3]	CONVENTIONAL ^{14}C AGE B.P.	ERROR	A.D. 2-σ RANGE[4]	TYPE OF ANALYSIS
WK-16731	8	Stepped platform (D)	Coastal	94	TP24	I	Lower part of oven associated w/ structure	*Sapindus saponaria, Artocarpus altilis,* and others	100	34	Post-1680	Radiometric
OZI-977	8	(As above)	Coastal	94	TP24	IIb	Layer below structure	Unidentified nutshell	855	45	1040–1270	AMS
WK-13836	11	Stepped platform (D)	Lowland	147	TP23	II	Top of Layer II; predates structure	*Hibiscus tiliaceus*	341	44	1450–1650	Radiometric
OZK-035	11	(As above)	Lowland	147	TP23	II	Burn layer under structure	*Thespesia populnea*	285	35	1490–1800	AMS
WK-16730	13	Stepped platform (D)	Lowland	59	TP20	I	In situ sample; dates structure	*Cordia subcordata*	178	34	Post-1640	AMS
OZK-038	13	(As above)	Lowland	59	A11	I	Fire feature below structure	*Terminalia glabrata*	125	40	Post-1670	AMS
OZI-978	16	Stepped terrace (C)	Coastal	31	TP17	I	In situ; possibly associated with structure	*Thespesia populnea*	65	45	Post-1680	AMS
WK-16728	16	(As above)	Coastal	31	TP17	II	Hearth below structure	*Cyclophyllum/ Eugenia?*	264	38	1520–1800	Radiometric
OZI-979	16	(As above)	Coastal	31	TP17	III	From lowest cultural layer, 110 cmbs	cf. *C. subcordata*	285	40	1480–1800	AMS

(Continued)

Table 2 (Continued)

LAB NO.[1]	STRUCTURE NO.	STRUCTURE MORPHOLOGY[2]	LOCALITY	AREA (m^2)	UNIT	LAYER	COMMENTS	MATERIAL[3]	CONVENTIONAL ^{14}C AGE B.P.	ERROR	A.D. 2-σ RANGE[4]	TYPE OF ANALYSIS
WK-13835	24	Stepped platform (D)	Mid-valley	62	TP22	IIa	Layer associated with structure	*H. tiliaceus, S. saponaria,* undetermined wood	153	36	Post-1660	Radiometric
WK-16729	29	Stepped platform (D)	Mid-valley	49	TP21	I	Layer associated with structure	*T. populnea, S. saponaria,* undetermined wood	125	35	Post-1670	AMS
WK-16734	32	Stepped platform (D)	Mid-valley	78	TP31	II	Layer under structure	*T. populnea, S. saponaria, C. subcordata*	260	34	Post-1490	AMS
WK-16733	33	Simple platform (E)	Mid-valley	41	TP30	II	Burning before structure	*T. populnea, S. saponaria, H. tiliaceus*	110	34	Post-1680	AMS
WK-16732	46	Simple platform (E)	Mid-valley	44	ST2	Ib	Dates possible pit, prob. assoc. with structure	*T. populnea* and 2 undetermined species	206	33	Post-1640	AMS
WK-10646	68	Pavement (A)	Coastal	22	TP7	I	Concentration of burnt nutshells assoc. with pavement	*Aleurites moluccana* nutshell	<200		Post-1750	Radiometric
WK-10842	68	(As above)	Coastal	22	TP7	I	Fire feature under pavement	*T. populnea, Morinda/ Glochidion, H. tiliaceus*	239	48	Post-1490	Radiometric

(Continued)

OZI-980	232	Pavement (A)	Mid-valley	6	SP1	II	From top of oven below pavement	*C. subcordata*	510	40	1310–1450	AMS
WK-16735	232	Pavement (A)	Mid-valley	6	SP1	II	From base of oven below pavement	Undetermined	716	38	1220–1390	Radiometric
OZK-036	242	Simple platform (E)	Inland	na	TP38	I	Fire-pit; dates Tepapa Uka cluster indirectly	Monocot wood	105	35	Post-1680	AMS
OZK-040	none	Earthen storage pit	Inland	na	TP39	I	Dates structure indirectly	*A. altilis*	210	35	Post-1640	AMS
OZK-037	254	Stepped platform (D)	Inland	98	TP40	II	Layer under structure	Nutshell or fruit endocarp, prob. coconut	735	35	1210–1380	AMS

1. WK = Waikato Radiocarbon Laboratory, NZ; OZ = Australian Nuclear Science and Technology Organisation; BETA = Beta Analytic, Inc., Florida.
2. Parenthetical letters refer to Suggs' (1961) foundation types; see Fig. 3.
3. Identifications by R. Wallace. Allen and Wallace (2007) recently identified *Cordia subcordata* as a relatively long-lived tropical species. They also list *Terminalia glabrata*, *Barringtonia asiatica,* and *Cocos nucifera* as species with maximal ages of nearly a century. In light of this, all *Cordia*, *Barringtonia*, *Terminalia,* and unidentified wood charcoal samples reported here potentially overestimate the age of these structures.
4. Calibrated with OxCal 3.10 (Bronk Ramsey 1995, 2001) using the Northern Hemisphere calibration curve, as per Petchey et al. (2009).

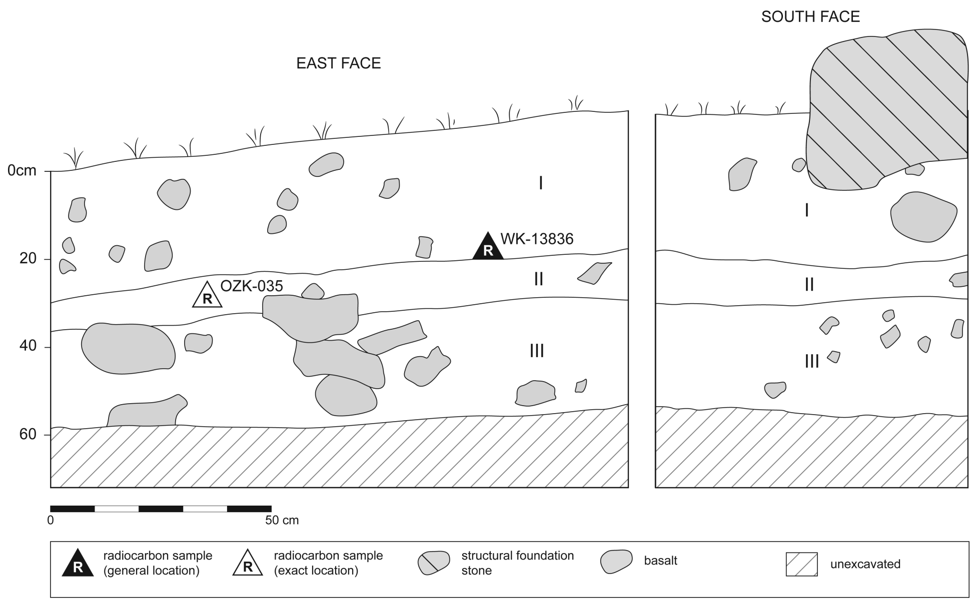


Fig. 14. Profile of excavation unit at Structure 11 showing location of radiocarbon samples.

Elsewhere dates on materials from below foundations provide maximal age estimates. In the northern half of the valley, at inland Structure 32, material from below the foundation dates to post-1520 A.D. (1σ range, WK-16734). At Structure 11, a burn layer below the structure (Layer II in Fig. 14) dates to A.D. 1520–1660 (1σ range, OZK-035). At nearby Structure 33, pre-structural burning dated to post-1690 A.D. (1σ range, WK-16733).

The dated series also provides evidence for use of the southern half of the valley and inland localities coincident with the earliest Teavau'ua occupation. Structure 232 (a pavement) is one of several structures sitting atop a relatively flat ridge crest, a cluster that also includes a high stepped platform (Structure 58) and a low stepped platform (Structure 229) (Fig. 15). An excavation unit (SP1) at the edge of the pavement (Structure 232) revealed an oven feature below and extending underneath this structure. Two radiocarbon samples from this oven produced a combined 1σ age range of A.D. 1260–1445 (OZI-980 and WK-16735). An excavation unit was also placed at the rear of the high stepped platform (Structure 58), within a poorly built enclosure interpreted as a recently constructed animal pen. This unit produced no charcoal and few cultural remains. Excavations next to the low stepped platform (Structure 229) produced historic materials and very little cultural deposit. Overall, the evidence points to three periods of cultural activity at this locality, with the surface architecture post-dating initial use, and some construction (i.e., Structure 229) likely to be post-Contact in age.

Excavation at another interior area also produced an early age estimate. A unit placed flush against the foundation stones of Structure 254 (Fig. 10) revealed dispersed charcoal in a layer beneath that associated with the foundation stones of this large platform. Dating to A.D. 1210–1380 (1σ range, OZK-037), this activity is again contemporary with the earliest occupation at Teavau'ua.

Fig. 15. Plan view and cross-section of inland residential complex (Structures 58, 229, 232).

More generally, the relatively late architectural dates are supported by stratigraphic evidence. Often there was little associated cultural deposit (e.g., Structures 29, 32, 33, 46, 240), consistent with the idea that these structures were not used over long periods of time. In several cases where earlier activities were identified, there is no evidence for associated stone structures (e.g., Structures 8, 11, 13, 16, 24, 68, 232). Structure 68 provides a particularly clear example with probable domestic features (hearths, ovens, and a postmold) in the absence of stone architecture underneath a surface pavement. Similarly, excavation to a depth of 120 m at a partially buried stepped terrace (Structure 16) exposed two small hearths and a postmold, but no earlier stone architecture (Fig. 11).

In addition to the foregoing, test units were opened at another nine structures. Samples from these units, however, have not been dated because of the absence of suitable materials, a lack of securely provenienced materials, or there was no clearly associated cultural deposit (e.g., the buildup of sediments against the structure face could not be unambiguously identified as cultural in origin). These excavations also suggest that raised structures were not occupied for extended periods of time, as there is little accumulated cultural debris and a lack of organic enriched sediments.

Overall, the similar age estimates on domestic foundations found in different parts of the valley suggest that the pattern of post-1640 A.D. ages is not an artifact of site location. Similarly, late dates on a range of structure morphologies, including pavements, simple platforms, and stepped structures, of both large and small sizes, indicate that all forms of foundations were in use in the post-1640 A.D. period and indeed at Anaho all dated examples of architecture date to the post-1640 period. Importantly, the dates provided here represent maximal age estimates as: 1) they date first use of the structures (or in some cases pre-structural activity); and 2) in some cases the radiocarbon samples could have involved long-lived species, although efforts were made to exclude these. Further, although an evolution of house foundation forms is possible, as suggested by undated but superimposed structures in Hanatekua Valley (Bellwood 1972), the Anaho findings point to a fairly rapid development of domestic architecture (e.g., over two to three centuries), at least in this valley.

DISCUSSION AND CONCLUSIONS

Key Findings of the Anaho Analysis

The most significant finding of the Anaho analysis is the demonstration that elaborated domestic architecture is a relatively late phenomenon. The 21 radiocarbon determinations, from both inland and coastal contexts, date 13 structures of varied size and form to the mid-seventeenth century A.D. or later. This finding is bolstered by evidence from the Teavau'ua coastal flat, where another eleven radiocarbon determinations date two prehistoric occupations without stone architecture to the pre-1600 period. This contrasts with Suggs' (1961) model of a lengthy evolution and the appearance of raised forms (his "terraced foundations") around the fourteenth to fifteenth centuries A.D.

A second finding is that Suggs' (1961) foundation typology (Fig. 3, upper illustration) apparently conflates chronological, functional, and topographical variability, calling into question its usefulness as a means of relative dating. Suggs argued for a progressive evolution of forms, from simple pavements, to divided pavement/terraces, to stepped platforms, the latter reaching considerable size in late prehistory. The Anaho evidence, however, indicates that topography and function also need to be considered in assessing the origins of morphological variability. Terraces, for example, are not chronologically distinctive at Anaho, and their occurrence appears to be tied to local topographic conditions, a relationship also noted on Hiva 'Oa (Bellwood 1972), 'Ua Huka (Kellum 1968), and elsewhere (Linton 1925 : 5). Simple pavements also are not necessarily chronologically restricted. Although they have been recorded in early contexts like those of Hane, 'Ua Huka, Hanamiai, and Tahuata, they also appear in late prehistoric settings such as the Hanapete'o Rockshelter on Hiva 'Oa (Skjolsvold 1972). At Anaho, pavements were commonly found alongside larger raised structures and apparently were associated with varied activities, such as food preparation, and possibly tattooing in the case of Structure 68 where a sizable cache of burnt *Aleurites* nutshells (a common tattoo pigment) was recovered.

There are however, other foundation characteristics which *do* appear to have temporal significance. Bellwood (1972 : 33–35) on Hiva 'Oa, for example, found that stepped foundations sometimes overlay, or appeared to have destroyed, simple terraces and platforms, suggesting a greater antiquity for the latter. Unfortunately, none of his examples are dated and sequences of this kind have not been identified in other valleys.

Other changes may date to the post-Contact period. In Anaho, there are several structures with historic associations (European artefacts, exotic trees, use of local cement in concreting walls, and/or known former occupants). In this subset, the basic stepped foundation form is retained but there are subtle differences in construction and raw materials. These structures are often of low height (typically one or two courses high), have façades comprised of small boulders of uniform size, and feature front verandas with flag-stone-style paving (e.g., Structure 229 in Fig. 15). Further, the façade stones on this subset of foundations are often oriented with their long axes running perpendicular to the foundation face (e.g., Fig. 16). These structures would have been considerably less costly to build relative to other Anaho examples that lack historic associations (compare Fig. 8 with Fig. 16), as the stones are much smaller and could easily be moved by individuals. Moreover, as a corollary of reduced height and smaller building materials, they required less engineering skill to construct. Notably, reductions in architectural investments also were observed by Kellum (1968) in Hane Valley, where a predominance of stone terraces gave way to stone-lined earthen terraces in the historic period. Suggs (1961 : 190) too notes that some post-Contact structures were more "cheaply" constructed, using "small, poorly selected stones and more easily obtained solid dirt fill."

Finally, it is worth noting that despite their overall brief histories, many structures at Anaho attest to considerable transformation over their life spans. At Structure 13, adjacent to the Teavau'ua Stream, a sequence of "home renovations" was made visible by recurrent episodes of flooding and sedimentation. Elsewhere house foundations have been incorporated into more recent enclosures (e.g., the rough pen attached to the back side of Structure 58 in Fig. 15) and traditional stepped platform risers have been transformed into European-style steps, presumably leading to wood-frame buildings. These modifications highlight the dynamic

Fig. 16. Example of historic house foundation, Structure 61.

nature of Anaho's architectural sites, despite their relatively short use-lives, and draw attention to important site formation issues that might affect interpretations of site use, occupation duration, and contemporaneity.

Archipelago-Wide Variability

How representative is the Anaho record of domestic architecture vis-à-vis the archipelago as a whole? A case is made above that the Anaho Valley house foundations are intermediate in size, relative to those from other valleys as known through archaeological study (i.e., Addison 2006; Bellwood 1972; Kellum 1968; Ottino 1986) and early ethnohistoric accounts (Bellwood 1972; Ferdon 1993), and by extension not atypical or un-representative, at least in form. With respect to the antiquity of raised foundations, unfortunately no comparable dataset exists. However, isolated records are available from several other localities, including examples on Tahuata and 'Ua Huka, and other Nuku Hiva localities.

The earliest example of a possibly terraced foundation comes from Hanamiai, Tahuata Island where Rolett (1998:79–81, 245) excavated part of a 20-cm-high, stone-faced pavement, built against a gentle slope. Dated to A.D. 1287–1436 (2σ age range), this could conceivably be a forerunner of later fully raised foundations but the evidence is at best suggestive given the limited area excavated. More definitive evidence comes from Spanish accounts dating to their A.D. 1595 visit and observations of raised house foundations on Fatu Hiva (in Kellum 1968).

In Hatiheu Valley on Nuku Hiva, Millerström (2001:288; see also Millerström and Coil 2008:334, Fig. 6, Table 2) obtained a date of post-1670 A.D. on a fire pit underlying a stone-faced residential terrace. A second unit placed in the general vicinity of a residential complex, but not adjacent to a residential structure, returned a date of post-1480 A.D. (Millerström and Coil 2008: Fig. 7, Table 2). In Taipivai Valley (NT-8), also on Nuku Hiva, three of the seven undated domestic structures excavated by Suggs (1961) produced European goods. The fill of Structure B contained an iron axe head, and burials in Structures E and F were associated with a carving knife and a metal ornament respectively, leading Suggs to conclude that the complex as a whole was abandoned shortly after western contact. It is noteworthy that the significant areal excavations at Ha'atuatua Beach (Rolett and Conte 1995; Suggs 1961), where the main occupation is now dated to the late thirteenth to mid-fifteenth century A.D., failed to identify any raised house stone foundations (although undated examples are found in the valley interior). On 'Ua Huka Island, a large residential structure in Manihina Valley was indirectly dated to post-1675 A.D. by a radiocarbon sample (Beta-116143) from a stratigraphically inferior layer (Conte and Poupinet 2002: 49) and Kellum (1968) opined that the inland Hane structures dated to the post-1600 period given the abundance of late style adzes. Overall, these isolated archaeological records are consistent with the more detailed Anaho analysis. As such, the currently available evidence provides little support for Suggs' fourteenth to fifteenth century age estimates for the appearance of raised house foundations on Nuku Hiva. Nonetheless, there are almost no dated examples from the southern Marquesas and only a few cases from the largest Marquesan valleys, areas which potentially could have different chronologies.

Possible Causes of Architectural Change

The chronological framework developed here allows consideration of how variability in domestic architecture might articulate with other social and natural processes. In particular, changes in domestic architecture might be expected to reflect the onset of processes that ultimately led to the distinctive Marquesan sociopolitical structure, including the dissolution of traditional chiefly powers, the rise of an independent priesthood, and the empowered warrior class found at western contact (Allen 2010; Kirch 1991; Suggs 1961; Thomas 1990). Intriguingly, however, historic accounts give the distinct impression that most, if not all, Marquesan families occupied raised stone foundations of some kind (e.g., Handy 1923; Stewart 1833). Similarly, the archaeological records of Anaho, Hane (Kellum 1968), Hanetakua (Bellwood 1972), and elsewhere (e.g., Conte and Poupinet 2002; Ottino 1986), point to widespread use of raised foundations, but at the same time, only a small number of very large and elaborated ones. These findings intimate that the appearance of raised foundations *per se* may not be directly linked to sociopolitical causes, as use of raised foundations apparently cut across social classes. At the same time, variability in foundation size, height, and ornamentation potentially signals sociopolitical changes of the kinds outlined above. Both the general appearance of raised house foundations, and marked elaboration of a smaller subset, warrant explanation and the two processes may not necessarily have been directly linked.

In considering sociopolitical transformations and the emergence of the distinctive Marquesan chiefdom, variability in the quality or availability of resources has been a central and recurring theme. Suggs (1961) pointed to population pressure on limited terrestrial resources, Thomas (1990) highlighted potential ecological crises (particularly extended droughts), and Kirch (1991) considered the interplay of demographic, environmental, and social processes. New evidence for climate variability in the central Pacific over the last millennium may be relevant in this regard. Of particular interest are recent fossil coral studies, especially those from Palmyra in the Line Islands (Cobb et al. 2003). Cobb and associates identify the "Medieval Warm Period" (c. A.D. 900–1250) as cool and dry, and the "Little Ice Age" (c. A.D. 1550–1850) as warm and wet in the eastern equatorial Pacific, a model which is increasingly supported by studies elsewhere (see review in Allen 2006; also Conroy et al. 2009; Graham et al. 2007). The Palmyra corals indicate several high magnitude El Niño events in the seventeenth century, with some rivaling the "Giant El Niño" of 1997–1998 (see also Gergis and Fowler 2009). Although the Pacific is regionally variable with respect to climate, both the Marquesas and the Line Islands lie within the same modern climatic subzone (Salinger et al. 1995), suggesting that the latter might be an appropriate model for the former. Assuming this is the case, the newly available paleoclimate records point to the second half of the sixteenth century through the nineteenth century as a period of enhanced temperatures, increased precipitation, and possibly greater storminess (see also Bridgman 1983) in the central eastern Pacific.

Our ongoing Nuku Hiva research provides some broadly corroborative local evidence for the onset of periodically wetter conditions in the seventeenth century. Generalized burning, probably forest clearance as a prelude to gardening, is indicated in the Anaho catchment from around the mid-fourteenth century, becoming more widespread over time. Impact on low-lying areas, however, is not registered until the seventeenth century, when the deposition of terrigenous sediments increases markedly in the vicinity of Teavau'ua Stream. Several structures in this area are today partially buried. Excavations in one (Structure 13) indicate repeated flooding in the post-1640 period, while those at another (Structure 16) point to significant aggradation (Fig. 11, Table 2). Even more dramatic evidence for increasingly wet conditions comes from Hakaea Valley where a series of massive flood events truncated the coastal dune and left a thick deposit of terrestrial sediments.

In a recent assessment of local and regional climate records, Allen (2010) argues that Marquesans faced *alternating* periods of extreme wet and dry and it was this variability, along with multiple scales of uncertainty, rather than droughts *per se*, that most strongly affected Marquesan life and ultimately fostered sociopolitical change. Articulations between climate variability and architectural developments were potentially multi-faceted. At the scale of individual households, raised foundations may have been an attempt to deal with changing background climate, specifically the onset of generally wetter conditions, or perhaps in response to one or more particularly large El Niño events. Indeed, the apparently rapid and widespread development of raised foundations in Anaho is consistent with expectations for the uptake and persistence of traits that offer functional advantages (Dunnell 1978), in this case improved comfort and possibly health. Further support for this somewhat mundane interpretation is found in the ethnohistoric literature. Crook (2007: 79; also Forster 1777: 335) specifically identified raised house foundations as a way to avoid floods during heavy rains. He also noted prohibitions against wet clothing inside the house, while Langsdorff (1968 : 136) reported that both washing and water spillage was forbidden indoors. The leading verandas, Langsdorff (1968 : 127) suggested, were designed to keep the house dry, although they also clearly served as spaces for social and domestic activities. Linton (1923 : 272) notes that platforms built on hillsides were made high enough to protect the houses from flooding and trenches were dug along the upslope edge to carry off water. Importantly, he also observed that pavements, as opposed to raised foundations, were more common in dry regions, as seems to have been the case in the leeward valleys of Hane (Kellum 1968) and Manihina (Conte and Poupinet 2002).

The Anaho record offers further insights into the impact of periods of heavy rainfall on domestic life. A number of stone foundations are found on flat ground paralleling the lower reaches of Teavau'ua Stream, as well as on the nearby southern slope. It seems likely that this stream-side community grew out of the Teavau'ua coastal occupation around the sixteenth to seventeenth centuries, a time when occupation on the immediate coastal flat nearly ceases. Sites along the stream include pavements, low stone structures, and raised foundations, variability that could be chronological. Notably, several structures adjacent to the stream are partially buried by alluvial sediments. Excavations at three point to repeated inundation, a situation which may have eventually encouraged people to move farther upslope. One of these, Structure 13, appears to have had a second course laid on its surface at some point during its use-life, possibly in response to periodic flooding.

Raised house foundations incorporate a secondary feature that also may relate to increased rainfall. With the appearance of elevated house structures, we see the development of stone-lined pits on the front paved verandas (e.g., Fig. 7). Varied functions have been assigned to these features. Late nineteenth- and early twentieth-century informants indicated they were used for fermenting breadfruit paste (*ma*) and for disposal of sacred items (Linton 1925 : 102; Suggs 1961 : 49; Tautain in Linton 1925). Von den Steinen (2005 : 37, Fig. 29) shows them being used for processing of breadfruit pulp in an 1884 photograph (see also Ottino 2006). Suggs excavated two in Taipivai Valley and found evidence of their use in cooking (1961 : 49, 51) and for inhumations (1961 : 51; see also Linton 1923 : 14), the latter probably a secondary function. Based on their proximity to taro terraces, Kellum (1968 : 71) suggested they were used for root crop storage. Regardless of their specific function(s), pits in raised foundations provided a way to store resources and valuables close to home, keep them relatively dry, and prevent their disturbance or theft by pigs, rats, and people. They undoubtedly reflect some combination of changing environmental (e.g., increased precipitation) and/or social (e.g., increased competition) conditions.

Other explanations for the appearance of raised foundations also bear consideration. Although not the case at Anaho, many Marquesan valleys are long and steep-sided. As flat low-lying areas were filled, communities may have by necessity moved up onto valley slopes; terracing would have facilitated use of these areas (see Linton 1923 : 272). However, these engineering considerations alone do not require the use of either stone or raised foundations, and varied forms of earthen hillside terraces are found elsewhere in the region (e.g., New Zealand, Society Islands, and southern Cook Islands). Further, this technological hypothesis does not explain the abundance of raised stone foundations in level areas.

Another possibility is that raised domestic foundations were introduced from outside the archipelago. Sweet potato and white-flower bottle gourd are both pre-European crops that ultimately derive from South America (Green 2000*a*; Yen 1974). Ferdon (1993:131–138) considers several other American species present in the Marquesas before 1800 that might have some antiquity in the archipelago. More apropos, Green (2000*b*:73) raises the possibility of extra-regional influences on Polynesian architecture, particularly Rapa Nui *ahu* monuments after A.D. 1100. In the Marquesan case, raised foundations may have been used first in community assembly places (*tohua*), structures that presumably have some antiquity given their apparent historical connections with West Polynesian *malae*; unfortunately, none of these have been systematically dated. It is also possible that Marquesan raised domestic structures, and the widespread use of megaliths, are an indigenous development, essentially elaboration of the simple boulder pavements now known from several early domestic contexts.

As additional examples of dated domesticate architecture become available, differentiating between these alternative hypotheses should be possible, as each has entailments for geographic patterning and rate of spread, as well as associations with other cultural and natural processes (Table 3). If the appearance of raised foundations is functional, and related to increased precipitation, then uptake should be rapid, appear first in wetter windward localities, and correlate with either the onset of generally wetter conditions (e.g., the so-called "Little Ice Age"), or high-amplitude, recurrent, or prolonged El Niño events. If raised foundations are largely a technological innovation, aimed at taking advantage of steeply sloping ground, then they should appear first in elevated contexts and post-date intensive use of more level areas found on coasts and alongside water-courses. Moreover, we would anticipate a secondary spread from slopes to adjacent level zones, where many raised house foundations are found today. Alternatively, if

Table 3. Potential explanations for changes in Marquesan domestic architecture and expected correlates

	Expectations		
Hypothesis	Rate of spread	Geographic patterning	Associated processes
Adaptation to increased precipitation	Rapid	Windward valleys first	Correlates with onset of LIA or follows high magnitude, prolonged, and/or multiple El Niño events
Adaptation to steep terrain	Rapid	In valleys where flat land is limited first	Post-dates intensive use of level areas and correlates with marked population growth
External contact	Gradual	From point of entry, along extant pathways of interaction	Correlates with other evidence for external contact
Local innovation	Gradual	From point of innovation, along extant pathways of interaction	No particular associations

raised house foundations are stylistic, and the result of external contact or local innovation, then a slower, more gradual spread is expected, with cultural transmission initially taking place between valleys that are already in regular contact, either because of tribal affiliations or exchange relationships.

The foregoing discussion relates to the appearance of raised domestic architecture generally. Elaboration of a smaller subset of domestic structures may reflect fundamental changes in Marquesan sociopolitical organization, transformations that could stem from environmental deterioration, as previously suggested by Thomas (1990), Kirch (1991), and more recently Allen (2010). The seventeenth century in particular appears to have been one of marked climatic variability, with the potential to destabilize or even destroy critical subsistence resources in both terrestrial and marine localities. Increased storminess is likely to have exacerbated erosion and run-off, potentially damaging both irrigated and dryland gardens. Declines in offshore fishing, documented throughout the archipelago (e.g., Rolett 1998; Sinoto 1966; Suggs 1961), may have been related to increasingly stormy conditions. The effectiveness of food storage devices developed during cooler, drier times may have been reduced as soils were frequently saturated. Coral reefs would have experienced not only elevated temperatures but also increased terrestrial sedimentation and possibly bleaching (Aswani and Allen 2008). Investigation into these potentialities is still at a preliminary stage, but clearly there should be distinct signals of decline in resources and health if the climate model outlined above is valid.

In this context, priests, warriors, and other secondary elites were provided with new opportunities for political gain and recruitment of followers, as hereditary chiefs failed in their traditional roles. There are numerous examples of disposed chiefs, population relocations, and even emigration as the result of declining fortunes (Suggs 1961; Thomas 1990). Drought and famine also may have been important in the rise of land ownership independent of rank and status (Allen 2010), as they led to both individual land parcels and sometimes entire valleys being abandoned (e.g., Robarts 1974 : 274). Specific features of sociopolitical change vis-à-vis climatic variability are explored in more detail elsewhere (Allen 2010), but important to the present discussion are the opportunities provided by raised stone foundations for displays of status, wealth, and power, as individuals sought to advertise their positions and gain followers. A subset of the Anaho structures illustrate this point, with variability in foundation size, height, façade stones (some up to 2 m across), and inclusion of non-local stones that required varying degrees of long-distance transport.

As discussed above, the Anaho evidence also suggests changes in domestic architecture in the post-Contact period, most notably a reduction in architectural investments. Such changes are not surprising in light of extreme post-Contact depopulation, the result of Old World diseases and a series of nineteenth-century famines. Accelerating after 1840 (Thomas 1990 : 4; 1996) and nearing 90 percent (Rallu 1990), population decline not only led to near-collapse of the traditional sociopolitical order, but also greatly diminished the available manpower for house construction. Interestingly, however, the two largest structures at Anaho have post-Contact associations. These are associated with known contact period elites, Chief Ko'oamua of Hatiheu and local Chiefess Kaniho. Similarly, the most impressive "megalithic *paepae*" observed by Suggs (1961 : 161) on Nuku Hiva Island was built in 1870 in Hatiheu, also by Chief Ko'oamua (see also Rolett 1998:248–249; Suggs 1961:37, 190). This variability in architectural investments within a single valley, where "cheaper" presumably commoner structures occur alongside very large elaborated elite ones, could reflect a variety of conditions, including growing economic inequalities, new functions for elite residences (e.g., use as arenas for intensified engagement with westerners), or elaboration of chiefly residences as focal points for group identity in the face of nineteenth-century social upheaval—possibilities that have yet to be explored.

CONCLUSIONS

This analysis provides the first absolute chronology of Marquesan house foundations, along with an alternative classification for formal description, and a protocol for dating of these relatively simple architectural features. Some of the difficulties of dating dry stone masonry architecture, especially unambiguously associating radiocarbon samples with feature construction, have been considered. The protocol outlined here makes explicit the ideals that guided this analysis and hopefully will aid development of a robust archipelago-wide chronology. The availability of samples both from strata associated with structure use, and from underlying strata, has been particularly useful in establishing structure age.

The Anaho research was undertaken with the expectation that domestic architecture in the valley would have a lengthy history (following Suggs 1961). The radiocarbon results, however, demonstrate this is not the case. Raised house foundations (including both terraces and platforms) are apparently a late prehistoric development at Anaho, and on more limited evidence, elsewhere in the archipelago. Other architectural forms such as pavements have a very long history, being found in both early and late contexts, and serving multiple functions.

Given the foregoing, progressive evolutionary ideas about the inherent necessity of increasing architectural complexity are problematic. Attention has been given here to the role of natural and social factors such as climate variability, elite competition, technological adaptations to steep topography, and the impact of European contact. The correlation between the appearance of raised house foundations after A.D. 1640 and changes in regional background climate, specifically the onset of warmer and wetter conditions, along with records of high magnitude El Niños in the seventeenth century A.D. (Cobb et al. 2003; Gerghis and Fowler 2009) is notable. Raised house foundations, and with them veranda storage pits, may have been an initial response to wetter conditions in particular. Climatic variability, to the extent that it adversely affected subsistence resources, also may have fueled sociopolitical competition and led to further elaboration of raised house foundations as a way to express differences in occupant status and wealth. After the mid-1800s, some households in Anaho reduced their architectural investments, possibly the result of population collapse due to western diseases. At the same time, some prominent elite constructed exceptionally large foundations, the most massive of the entire sequence.

Although further evidence is needed from other valleys to fully evaluate these ideas, the Anaho case provides a much needed radiocarbon chronology for Marquesan domestic architecture and a series of testable hypotheses about the underlying causes of architectural variation that hopefully will stimulate further study.

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ABSTRACT

Marquesan domestic architecture, including stone pavements, platforms, and terraces, potentially provides a useful case study into how varied social and natural processes might influence structure morphology. However, despite the prominent role that domestic architecture has played in the archipelago's traditional cultural historical sequence, only a few isolated examples have been directly dated. This analysis provides the first absolute chronology of Marquesan house foundations, along with an alternative classification scheme of formal morphology, and a protocol for dating these relatively simple architectural features. A suite of 33 radiometric and AMS determinations from Anaho Valley, Nuku Hiva Island, place the appearance of raised house foundations in the post-1640 A.D. period, considerably later than expected on conventional archaeological wisdom. The newly established absolute chronology allows linkages with other social and natural processes to be explored. The appearance of raised domestic foundations correlates with regional evidence for the onset of wetter conditions, while further elaboration (e.g., increases in size, height, façade stones, and use of exotic materials) of a smaller subset of structures is suggested to be a secondary development related to changing sociopolitical conditions. Western contact may have had further influences, with introduced diseases limiting manpower for megalithic constructions, and other processes affecting elite residences. Keywords: domestic architecture, sociopolitical process, climate variability, Little Ice Age, radiocarbon chronology, megalithic architecture, post-Contact depopulation, Marquesas Islands, East Polynesia.